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Biodiversity of Spider and Other Arthropods Inhabiting Cowpea under Effect of Fish Culture Water and Nitrogen Fertilization and its effect on Yield and Protein at Fayoum Governorate, Egypt

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ABSTRACT

A spilt plot design field experiment was conducted at Ibshway, Fayoum governorate, Egypt 2017 to study the effect of two sources water (fish culture water and Nile water) and nitrogen levels fertilizer on biodiversity of Spider and other arthropods, also, its effect on yield and protein of cowpea. Community composition of collected spider was determined throughout the period of study using the Shannon-Wiener and Simpson Indices of diversity. A total of 394 individuals (228 fish cultural water and 166 Nile fresh water) represented by 10 families of 19 identified genera, of higher diversity index in fish culture water system. According to Simpson, it was found that Fish culture water system included the highest number of dominant species. Family Lycosidae recorded the highest number of spiders where 170 individuals with two egg sac and 123 individuals with two egg sac of fish culture water system and Nile freshwater system respectively. Sørensen Quotient of Similarity between Fish culture water system and Nile fresh water system are nearly approximate, as they recorded 64 % of similarity by 81.25%. Other Arthropods were represented by 23 species belonging to 16 identified families, 7 unidentified families, and 12 orders. A total of 2832 individuals in fish culture water system and 2169 individuals in Nile freshwater system were counted from 9 observations on cowpea from seedling to maturity by using pitfall trap. A total of 471 individuals in fish culture water system and 592 individuals in Nile freshwater system by using Leaves. Statistical analysis for spider, soil fauna and pests on leaves proved that no significant differences were observed between Fish culture water and Nile water but significant differences in yield and protein. Nitrogen levels were no significant differences in spider and soil fauna but significant differences in pests on leaves, yield and protein. Interaction between water sources and Nitrogen levels were no significant differences in spider but significant differences in soil fauna, pests on leaves, yield and protein.

Key words: Fauna, Biodiversity, Spider, Fish culture water, Nitrogen, Fertilizer.

INTRODUCTION

Cowpeas (blackeye peas, or simply beans in many parts of Africa), *Vigna unguiculata*, L (Walp) are widely grown in the tropics and subtropics for human as well as for animal food. They are eaten as green seeds, green pods, and dry grains. Tender leaves are used as a vegetable (Kayumbo, 1978).

Soil fauna communities are critical for ecosystem function, with respect to direct and indirect interactions with plants, nutrient, and organic matter cycling (Wardle, 2004 and Mace, *et al.* 2012).

Agricultural practices can be both beneficial and detrimental to soil biota. The various management practices that influence populations and activity of soil biota include: tillage, stubble retention, and crop rotation, application of fertilizer, pesticides, irrigation, and soil compaction, indicated that population size and community structure of soil fauna are strongly influenced by agriculture practices. Rizk and Mikhail (2000).

In Egypt, cowpea has been subjected to attack by several pests (Harakly, 1972 and El-Kifl *et al*., 1974). The whitefly (WF) *Bemisia tabaci* and the two-spotted spider mite (TSSM) *Tetranychus urticae* have been reported as severe cowpea pests in Southern Upper Egypt (Abdel-Alim, 1994 and Abou El-Saad, 1998).

Survey of Acari, insect pests, predators and parasitoids associated with cowpea varieties were reported by (Helal *et al.,* 2003 and Abo-El Naga, 2011). The use of organic amendments applied to soil not only enhances its nutrient status but also reduces the incidence of pest (Adilakshi *et al.,* 2007).

Agricultural management has a considerable effect on the activity of spiders, (Cole *et al.*, 2005 and Fuller et al., 2005) found more spider activity in organic wheat than conventional. Inorganic management, where the agro-chemical application is prohibited, diversity of spiders is economically important (Östman *et al.*, 2003). (Surekha and Rao, 2001 and Prakash *et al.,* 2002) had earlier explored the use of organic farming for managing the pests of okra. Organic practice may add diversity to the soil structure and increase the abundance of prey and in turn the abundance of spiders (Öberg, 2007).

Recycling the drainage water of fish farming, rich with organic matter for agriculture use can improve soil quality and crops productivity (El-nwishy *et al.,* 2006). Reduce the total costs since it decreases the fertilizers used, which demand became affected by the prices and the framer's education (Ebong & Ebong, 2006).

Fishponds have a pivotal role in the nutrient dynamics since organic amendments are converted into fishes, shrimps or aquatic plants, and nutrient-rich pond sediments can be recycled as fertilizer for agricultural crops (Jamu and Piedrahita, 2002; Chikafumbwa, 1996).

This research investigated the effect of water fish culture and inorganic fertilizer on arthropod: pests and predators inhabiting cowpea in Fayoum Governorate.

MATERIALS AND METHODS

a. Experimental design:

The present investigation was conducted at Ibshway region, Fayoum governorate during a season, 2017. Seeds of cowpea (*Vigna unguiculata*, L.; Solanaceae) was Teba variaty. A spilt plots design with three replicates was used. Two irrigation water sources (WS); fish cultural water (FCW) and Nile fresh water (NFW). During soil preparation, calcium supper phosphate (15.5% P_2O_5) at the rate of 46.5 kg/fed was broadcasted. Cowpea was sown in the experimental field 16 August in rows of 70 cm wide and 3.0 m long with intra row spacing of 10 cm. Three nitrogen fertilization levels: 20, 40 and 60 unit/ fed (ammonium nitrate, 33.5% N) was added in two equal doses after 3 weeks and 5 weeks from sowing. This experiment carried out to study the effect of two irrigation water sources (WS) and nitrogen levels fertilization on:

1- Biodiversity of spiders and other arthropods:

Soil fauna was sampled by using pitfall traps method as described by Southwood (1978) and Slingsby & Cook (1986). Three pitfall traps were placed in each fertilizer treatment every ten days. Samples were sorted in the laboratory; collected spiders and others soil fauna were kept in glass vials containing 70% ethyl alcohol and some droplets of glycerin, counted and identified to species as much as possible.

2- Population abundance of pests and their associated predators:

Every ten days counts of pests and predators were counted eight weeks. Samples of ten leaves/ replicate were randomly picked, placed directly in paper bags and transferred to the laboratory for examination. Counts of pests and predators were recorded.

3- Yield and protein of cowpea:

In the suitable maturing and ripening stage, fruits from the whole three plants from the middle rows of each sub-plot were picked and weight, Total yield (ton/fed.) (in every picking date).Total protein (%) was measured using micro-Kjeldahl apparatus according to the method described in A.O.A.C. (1965).

Soil samples were randomly collected from the experimental site before sowing and during land preparation from the top layer (0 - 30 cm) for soil physical and chemical analysis. Soil physical properties were analyzed using the procedures described by Klute (1986), while soil chemical analysis was determined according to *Page et al.*, (1982) and P was determined according to Chapman and Pratt (1961). Soil physical and chemical properties are presented in (Table 1) and analysis of nitrogen in fish culture water in (table 2)

Table (1): some initial physical and chemical soil properties of the studied soil (0-30)

Particle size distribution					
Sand%		Silt%	Clay%	Texture class	
79.00		6.60	14.40	Clay loam	
Available nutrient ppm			Soluble anions meq/L		
N	P	K	Cl-	Hco3-	Co3-
50	4.6	4.20	2.5	1	20.6
Organic matter %					
Ec ds/m		PH 1:2.5 extract		CEC meq/100 soil	
0.9		7.9		-	
Caco3 %					
2					
Exchangeable cautions meq/100 soil					
Ca++		Mg++		Na+	
2.6		3.2		16.8	

Table (2): analysis of nitrogen in fish culture water as a source of irrigation to cowpea plants

No. of Irrigation	Date	Nitrogen/ppm
1	01-Apr	0
2	15-Apr	8
3	30-Apr	10
4	15-May	15
5	30-May	18
6	14-Jun	22
7	04-Jul	28
8	26-Jul	35

b. Frequency and abundance values

The frequency values of the most abundant species were classified into three classes according to the system adopted by Weis Fogh (1948); "Constant species" more than 50% of the samples, "accessory species" 25-50 % of the samples and "accidental species" less than 25%. On the other hand, the classification of dominance values were done according to Weigmann (1973) system in which the species were divided into five groups based on the values of dominance in the sample; E dominant species (>30% individuals), dominant species (>10-30% individuals), subdominant (5-10% individuals), resident species (1-5% individuals) and sub resident species (<1% individuals).

c. Species diversity

The biodiversity of collected spider were measured by diversity index that reflected the number of spider species (richness) in the samples. Two common indices were computed, Shannon-Wiener index "H" and Simpson index "S". They were calculated as described by Ludwig and Reynolds (1988) as follow:

$H' = -\Sigma (ni/n) \ln (ni/n)$

$S = \Sigma (ni/n)^2$

Where: ni is the number of individuals belonging to the i^{th} of "S" taxa in the sample and "n" is the total number of individuals in the sample. "H" is more sensitive to changes in a number of species and diversity, while "S" is a dominance index gives more weight to common or dominant species (Ludwig & Reynolds, 1988); it highly suggests that the two individuals drawn at random from the population belong to the same species. If the result is high then the probability of both individuals belonging to the same species is high, and as a result, the diversity of the community samples might be low.

d. Sørensen quotient of similarity

To allow a comparison of the two samplings between microhabitats of the two cultivation systems, Sørensen's quotient of similarity (Sørensen, 1948) was used to determine the similarities of spider species composition among the communities, it is: QS = 2 C/A + B.

Where A and B are the number of species in samples A and B, respectively, and C is the number of species shared by the two samples; QS is the quotient of similarity and ranges from 0-1. [A = Organic management, B = conventional management].

e. Dominance and abundance Percentages of the recovered species:

By using the same above mentioned samples, dominance and abundance percentages of arthropod pests and predators inhabiting cowpea plantations were determined by the formula(s) of Facylate (1971) as follows:

1- D = (t/T) x 100

Where: D= Dominance percentage. t= Total number of each species during collecting period.

T=Total number of all species collected during the collecting period.

2- A = (n/N) x 100

Where: A= Abundance percentage n= Total number of samples in which each species appeared.

N= Total number of samples taken all over the season.

f. Statistical analysis:

All collected data for various parameters were statistically analyzed according to the technique of analysis of variance for split-plot arranged in randomized complete block design using the InfoStat computer software package (version, 2012). The differences among treatment means were compared by LSD as a post hoc test at ≤ 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

I- Spider collecting

Tables (3 and 4) showed that the collected spiders recorded were 394 individuals (228 fish cultural water and 166 Nile fresh water), represented by 10 families of 19 identified genera. The 10 families found in the present study represent 25% of the 40 families recorded in Egypt (El-Hennawy, 2006).

Spiders inhabiting a land of management

1- Fish culture water

A total of 228 spiders were collected in soil irrigated with fish culture water. They were identified to 9 families, 17 genera, and 17 species. Family: Theridiidae was disappeared.

a. N_{20} fertilizer: Spiders recorded were 159 individuals. Juvenile comprised 84.28%, while adults averaged 15.72%. The sex ratio was 1.08 male: 1 female. The most abundant species were *Micaria dives*, Gnaphosidae (11 individuals) and *Pardosa sp.*, Lycosidae (6 individuals). Families Theridiidae, Euticharidae, Agelenidae and Dictynidae were disappeared.

b. N_{40} fertilizer: Spiders recorded were 46 individuals. Juvenile comprised 36.96%, while adults averaged 63.04%. The sex ratio was 2.63 male: 1 female. The most abundant species were *Micaria dives*, Gnaphosidae (17 individuals) and *Hogna ferox*, Lycosidae (8 individuals). Families Theridiidae and Araneidae were disappeared.

c. N_{60} fertilizer: Spiders recorded were 23 individuals. Juvenile comprised 21.74%, while adults averaged 78.26%. The sex ratio was 0.8 male: 1 female. The most abundant species were *Micaria dives*, Gnaphosidae (6 individuals) and *Wadicosa fidelis*, Lycosidae (5 individuals). Families Theridiidae, Euticharidae, Araneidae, Agelenidae and Dictynidae were disappeared.

2- Nile fresh water:

A total of 166 spiders were collected in soil irrigated with Nile fresh water. They were identified to 7 families, 15 genera, and 15 species. Families Araneidae, Agelenidae and Dictenidae were disappeared.

a. N_{20} fertilizer: Spiders recorded were 16 individuals. Juvenile comprised 25%, while adults averaged 75%. The sex ratio was 1male:1 female. The most abundant species was *Micaria dives*, Gnaphosidae (7 individuals). Families: Araneidae, Agelenidae, and Dictynidae were disappeared.

b. N_{40} fertilizer: Spiders recorded were 127 individuals. Juvenile comprised 81.89%, while adults averaged 18.11%. The sex ratio was 1.88 male: 1 female. The most abundant species were *Micaria dives*, Gnaphosidae (6 individuals) and *Hogna ferox*, Lycosidae (5 individuals). Families Euticharidae, Araneidae, Agelenidae, and Dictynidae were disappeared.

c. N_{60} fertilizer: Spiders recorded were 23 individuals. Juvenile comprised 39.13%, while adults averaged 60.87%. The sex ratio was 2.5 male: 1 female. The most abundant species were *Micaria dives*, Gnaphosidae (5 individuals) and *Wadicosa fidelis*, Lycosidae (5 individuals). Families Theridiidae, Euticharidae, Araneidae, Agelenidae and Dictynidae were disappeared.

Ayman *et al.*, (2015) indicated that spiders were 55 individuals collected from organic matter, they were identified to 7 families, 15 genera, and 15 species compared with 54 spiders were cached in the treatment of Standard fertilization, they were identified in 7 families, 14 genera, and 14 species.

Species richness

Tables (3, 4) show that among the 24 species of the spider collected during this study, 17 species of 9 families were recorded in soil irrigated with fish culture water and 15 species of 7 families in soil irrigated with Nile fresh water system.

A total of 10 families had a common occurrence in all treatment. Family Theridiidae was absent in soil irrigated with fish culture water as an organic system. But families: Araneidae, Agelenidae, and Dictynidae were absent in soil treated with Nile fresh water system.

Family Lycosidae recorded the highest number of spiders 170; individuals with two egg sac and 123 individuals with two egg sac of fish culture water system and Nile freshwater system respectively. The highest number of spider belonging to family Lycosidae 139 individuals and 110 individuals in fish culture water (N_{20})and Nile fresh water (N_{40}); it was the only dominant family, comprised 81.18% and 89.43% of the total catch fish culture water system and Nile freshwater system respectively.

Our results agreed with Hafiz and Abida (2009) recorded the highest number of spiders, 4645 spiders belonging to 7 families, 16 genera and 21 species in organic matter. Moreover, Bengtsson *et al.*, (2005) indicated this result which found that organic farming usually increases species richness, having an average 301 higher species richness than the conventional farming system. The same result was recorded by Schmidt *et al.,* (2005) who recorded the higher spider densities in organic field which is a favorable habitat for spiders. Also, Tahir & Butt (2009) found in their study that Lycosidae was the only dominant family, comprised 77.37 % of the total catch.

Zaki *et al.*, (2015) found that spiders were collected in organic farming 55 individuals, they were identified to 7 families, 15 genera, and 15 species compared with 54 spiders were cached in the treatment of nitrogen fertilization, they were identified in 7 families, 14 genera, and 14 species. Also, Zaki *et al.*, (2015) found that Family Lycosidae recorded the highest number of spiders of 165 individuals with one egg sac. In organic farming the highest number of spider belonging to family Lycosidae compared with nitrogen fertilization received low numbers; it was the only dominant family, comprised the highest number of the total catch organic compared with nitrogen fertilization respectively.

Frequency and abundance values:

Table (5) showed exhibits of spiders associated with cowpea plants as affected by different organic fertilizers. Family Lycosidae was considered “Constant” in fish culture water system and Nile freshwater system according to Weis Fog system which occupied 74.65% and 74.09% respectively, of the collected spiders. Members of this family: *Wadicosa fidelis*, *Pardosa sp.* and *Hogna ferox* ranges between "E dominant", “Sub dominant” and “Recedent” in fish culture water system and N fertilizer system according to Weigmann classification of dominance.

The present results agree with that of Hafiz and Abida (2009) who indicated that family Lycosidae was dominant. Also, the results are in accordance with Eyre *et al.*, (2008) as they stated that linyphiid species prefer plants in conventional cultivation and larger lycosidae and gnaphosidae species prefer the organic cultivation. A wide range of species can occur in arable fields, of which money spiders wolf spiders (Lycosidae) are the most abundant one (Alford, 2003). Rizk *et al.*, (2015) consent this result, that family Lycosidae was considered "Constant" according to Weis fog system, in the two type of cultivation organic and conventional, occupied 83.5 and 78.9% respectively.

Species diversity

Table (6) compares the biodiversity of spiders collected from cowpea plants in the different irrigation (fish culture water system and Nile freshwater) by using Shannon-Wiener "H" and Simpson "S" Indices of diversity. The vegetations of

Table (3): Species richness of spiders inhabiting soil irrigation with fish culture water associated cowpea plants

Families &taxa names	Fish culture water									Σ			Σ	Total	%
	N20			N40			N60								
	♂	♀	*j*	♂	♀	*j*	♂	♀	*j*	♂	♀	*j*			
Lycosidae			129			4				0	0	133	133		
Wadicosa fidelis	1	1		1	2	1	2	2	1	4	5	2	11	170 + 2▲	74.65
Pardosa sp.	3	1	2	2	1	2		3	1	5	5	5	15		
Hogna ferox		2		4	1	3		1		4	4	3	11		
Gnaphosidae										0	0	0	0		
Micaria dives	5	6		9	4	4	3	3		17	13	4	34	38	16.67
Zelotes sp.	1						1		2	2	0	2	4		
Linyphidae										0	0	0	0		
Mermessus denticulatus				1						1	0	0	1	2	0.88
Sengletus sp.		1								0	1	0	1		
Philodromidae										0	0	0	0		
Thanatus albini	2		1	1						3	0	1	4	6	2.63
Philodromus sp.							1		1	1	0	1	2		
Salticidae			1					1		0	1	1	2		
Heliophanus sp.				1						1	0	0	1	6	2.63
Phlegra flavipes	1	1					1			2	1	0	3		
Thridiidae										0	0	0	0		
Auryopis sp.										0	0	0	0	0	0
Steatoda erigoniformis										0	0	0	0		
Euticharidae										0	0	0	0	2	0.88
Cheiracantium siwi				2						2	0	0	2		
Araneidae			1							0	0	1	1	1	0.44
Agelenidae						2				0	0	2	2	2	0.88
Dictynidae						1				0	0	1	1	1	0.44
Total	13	12	134	21	8	17	8	10	5	42	30	156	228		
	159+1▲			46+1▲			23			228+2▲					

Table (4): Species richness of spiders inhabiting soil irrigation with Nile fresh water associate cowpea plants

Families &taxa names	Nile fresh water									Σ			Σ	Total	%
	N20			N40			N60								
	♂	♀	*j*	♂	♀	*j*	♂	♀	*j*	♂	♀	*j*			
Lycosidae						99			2	0	0	101	101		
Wadicosa fidelis		1		1	2		1	2	2	2	5	2	9	123 + 2▲	74.09
Pardosa sp.			1	1		2	1			2	0	3	5		
Hogna ferox		2		2	3			1		2	6	0	8		
Gnaphosidae										0	0	0	0		
Micaria dives	4	2	1	3	3		3		2	10	5	3	18	18	10.84
Zelotes sp.										0	0	0	0		
Linyphidae										0	0	0	0		
Mermessus denticulatus	1			2			1			4	0	0	4	6	3.62
Sengletus sp.							1	1		1	1	0	2		
Philodromidae										0	0	0	0		
Thanatus albini			1	1		2	2		2	3	0	5	8	11	6.63
Philodromus sp.				1		1	1			2	0	1	3		
Salticidae		1							1	0	1	1	2		
Heliophanus sp.				2						2	0	0	2	5	3.01
Phlegra flavipes				1						1	0	0	1		
Thridiidae										0	0	0	0		
Auryopis sp.	1									1	0	0	1	2	1.2
Steatoda erigoniformis				1						1	0	0	1		
Euticharidae										0	0	0	0	1	1.49
Cheiracantium siwi			1							0	0	1	1		
Araneidae										0	0	0	0	0	0
Agelenidae										0	0	0	0	0	
Dictynidae										0	0	0	0	0	
Total	6	6	4	15	8	104	10	4	9	31	18	117	166		
	16+ 1▲			127+1▲			23			166+2▲					

Table (5): The dominance-frequency relationship of spider communities associated with cowpea plants affected by two water sources

Families &taxa names	Fish culture water					Nile water				
	Total	Sp%	Dom.	F.%	Frq.	Total	Sp%	Dom.	F.%	Frq.
Lycosidae	133	58.33	E			101	60.84	E		
Wadicosa fidelis	11	4.82	R	74.65	C	9	5.42	sd	74.09	C
Pardosa sp.	15	6.58	sd			5	3.01	R		
Hogna ferox	11	4.82	R			8	4.82	R		
Gnaphosidae										
Micaria dives	34	14.91	D	16.67	A	18	10.84	D	10.84	A
Zelotes sp.	4	1.75	R							
Linyphidae										
Mermessus denticulatus	1	0.44	Sr	0.88	A	4	2.41	R	3.61	A
Sengletus sp.	1	0.44	Sr			2	1.20	R		
Philodromidae										
Thanatus albini	4	1.75	R	2.63	A	8	4.82	R	6.63	A
Philodromus sp.	2	0.88	Sr			3	1.81	R		
Salticidae	2	0.88	Sr			2	1.20	R		
Heliophanus sp.	1	0.44	Sr	2.63	A	2	1.20	R	3.01	A
Phlegra flavipes	3	1.32	R			1	0.60	Sr		
Thridiidae										
Auryopis sp.					A	1	0.60	Sr	1.20	A
Steatoda erigoniformis						1	0.60	Sr		
Euticharidae										
Cheiracantium siwi	2	0.88	Sr	0.88	A	1	0.60	Sr	0.60	A
Araneidae	1	0.44	Sr	0.44	A					
Agelenidae	2	0.88	Sr	0.88	A					
Dictynidae	1	0.44	Sr	0.44	A					
Total	**228**					**166**				

Frequency (abundance), by Weis Fog
> 50 % = Constant (C)
25 - 50 % = Accessory (ac)
> 25 % = Accidental (A)

Dominance, by Weigmann
> 30 % = Eudominant (E) 1 - 5 % Recedent (R)
10 - 30 % = Dominant (D) > 1 % = Subrecedent (Sr)
5 - 10 % = Subdominant (sd)

Table (6): Estimation of Shannon-Wiener and Simpson Indices of spider diversity in Fish culture water system and Nile fresh water system.

	Fish culture water system	Nile fresh water system
Shannon-Wiener Index	1.53	1.54
Simpson Index	0.37	0.39

different treatment varied in their spider richness. The collected spiders from cowpea plants irrigated with fish culture water system recorded the highest population (228 individuals), while irrigated with Nile fresh water recorded the least species richness (166 individuals).

According to Shannon-Wiener "H" Index, fish culture water system recorded 1.53 of 17 species and 9 families, while Nile fresh water recorded 1.54 of 15 species and 7 families, therefore, it could be concluded that enhanced that fish culture water system had a higher diversity index and Nile fresh water had a lower diversity index.

According to Simpson Index, which reflected the measure of dominance, it was found that Fish culture water system included the highest number of dominant species of values 0.37, Lycosidae members recorded 170 individuals.

The present results are in agreement with Zaki *et al.*, (2015) found that the spiders collected from tomato plants treated with organic matter recorded the highest population while nitrogen fertilization recorded the least species richness. Moreover, found that organic farming had a higher diversity index compared with nitrogen fertilization. Also, Schmidt *et al.*, (2005) found that the abundance of spiders in organic fields was more than conventionally.

Similarity of species

A community of spiders collected from Nile fresh water system (166 indv.) was lower than those collected from Fish culture water system (228 indv.), while the number of spider species was greater in Fish culture water system (17 sp.) than that of Nile freshwater system which recorded (15 sp.). To estimate spider composition of that different microhabitat, Sørensen's quotient of similarity was applied by comparing the number of species and individuals of two communities. It is concluded that the similarity to Nile freshwater system compared by Fish culture water system recorded 0.8125 that is to say that community of Fish culture water system nearly resembled a community of Nile fresh water system by 81.25%. Zaki *et al.*, (2015) concluded that the community of organic farming nearly resembled a community of standard by 89%.

II- Total numbers of Soil fauna by pitfall trap:

Arthropod pests and predators reside from cowpea plantations are reported in Table (7). Arthropod pests and predators were represented by 23 species belonging to 16 identified families, 7 unidentified families, and 12 orders. In a similar study, El-Sayed (1993) recorded 16 insect pest species and 8 arthropod predators in addition to 8 parasitoid species in association with cowpea plantations in Minufiya Governorate. Also, Amro (2004) recorded that fifteen phytophagous species and five arthropod predators in addition unidentified true spiders to determined during 2000 and 2001 growing seasons in Assiut Governorate.

III- Dominance and abundance degrees of arthropod pests and their natural enemies:

Table (7) indicated a total of 2832 individuals in fish culture water system and 2169 individuals in Nile freshwater system were counted from 9 observations on cowpea from seedling to maturity by using pitfall trap.

In fish culture water system, the highest number of individuals was 1118, 887 and 827 in N_{20}, N_{60} and N_{40} respectively. But in Nile fresh water system, the highest number of individuals was 818, 736 and 615 in N_{40}, N_{20}, and N_{60} respectively. The dominance and abundance degrees indicated that Formicidae, Collembola, and Spiders recorded the highest dominant and abundant in both fish culture water system and Nile fresh water system. (Okada & Harada, 2007 and Birkhofer *et al.*, 2008) indicated that the application of both organic and inorganic fertilizers to ecosystems has been shown to increase the populations and diversity of soil fauna.

Table (8) showed that a total of 471 individuals in fish culture water system and 592 individuals in Nile freshwater system were counted from 8 observations on cowpea from seedling to maturity by using Leaves. The highest number and dominance degree of individuals recorded was N60 fertilizer in both fish culture water system and Nile fresh water system. Order Diptera, family Agromyzidae was the highest abundant in both fish culture water system and Nile fresh water system.

This finding incongruity with those documented by Salem *et al.*, (2012) and Abdel-Galil & Amro (2014) found that some predators help in planning Integrated Pest Management (I.P.M.) strategies.

Abou El-Saad (2015) showed that the highest dominance and abundance were recorded with the piercing-sucking pests; *Tetranychus urticae* and *Bemicia tabaci* followed by *Empoasca decipiens* and *Aphis gossypii* as for the natural enemies; *Scolothrips longicornis* followed by *Orius sp.*, *Coccinella undecimpunctata* and *Chrysopa Carnea*.

IV - Effect on yield

a. Effect of water sources: Table (9) show that total yield was significantly increased by two water sources where the highest yield was obtained by Fish culture water (930.59 kg/fed.) compared with Nile water was (848.32 kg/fed.).

Castro *et al.*, (2005) found that treatments irrigated with fish effluent had higher fruit number/plant and productivity at 50, 75 and 100 days age in a tomato plant.

Also, Kamal (2006) found that plant height, market fruit weight(g), marketable ripe fruit yield, mean yield of marketable fruits (kg/m2) and mean total yield of fruits of bell pepper grown hydroponically in a closed, reticulating fish and bell pepper production system were significantly increased when bell pepper plants/m2were reduced from 15 to 10 plants/m^2.

b. Effect of nitrogen: From Table (9), it is also clear that was significantly increased by added levels nitrogen fertilizers (N_{20}, N_{40}, and N_{60}) where the highest yield was 999.88 kg/fed. in N_{60}, N_{40} was 875.48 kg/fed and N20 was 793.01 kg/fed.

Todorov and Pevicharova (2000) stated that applying 10 kg/ammonium nitrate/do result in standard production on the average increase of 1.5-18.8%.

Upadhyay and Anita (2016) found that the treatments were four levels of nitrogen (0, 10, 20 and 30 kg/ha) the effect of nitrogen on a yield of cowpea was significantly increased on seeds/pod and grain yield.

c. The interaction effect between water sources and nitrogen levels: Table (9) showed that the main effect of interaction between irrigation water sources and nitrogen fertilization on total yield was highly significant and the trend was similar. The highest yield was 1077.41 kg/fed in the interaction between fish culture water and nitrogen fertilizer (W_1N_{60}).

In contrast, the lowest yield was 775.84 kg/fed. in the interaction between Nile freshwater and nitrogen fertilizer (W_2N_{20}).

(Wesley *et al.*, 2001) recommended that fish pond effluent applied as irrigation and as a supplemental source of nutrients is beneficial for French bean and kale growth and yield. However, pond effluent should

Table (7): Dominance and abundance (D & A) of arthropod pests and their natural enemies collected from cowpea plantation using pitfall traps in fish culture water and Nile fresh water during 2017 season, Fayoum Governorate

Order	Family	Fish culture water									Nile fresh water								
		N20	D%	A%	N40	D%	A%	N60	D%	A%	N20	D%	A%	N40	D%	A%	N60	D%	A%
Coleoptera	Carabidae	2	0.18	33.33	10	1.21	55.56	8	0.90	44.44	2	0.27	22.22	1	0.12	11.11	2	0.33	22.22
	Staphylinidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0.12	11.11	0	0	0
Collembola	Collembola	233	20.84	100	223	27.03	100	142	16.05	88.89	139	18.89	100	176	21.52	100	150	24.39	100
Diptera	Muscidae	40	3.58	77.78	66	8.00	100	50	5.65	100	62	8.42	88.89	57	6.97	88.89	55	8.94	100
	Syrphidae	1	0.09	11.11	0	0	0	0	0	0	3	0.41	22.22	1	0.12	11.11	1	0.16	11.11
	Culicidae	0	0	0	1	0.12	11.11	0	0	0	2	0.27	22.22	0	0.00	0.00	0	0	0
Heteroptera	Anthocoridae	0	0	0	0	0	0	0	0	0	0	0	0	2	0.24	11.11	0	0	0
	Miridae	1	0.09	11.11	0	0	0	2	0.23	33.33	0	0	0	1	0.12	11.11	2	0.33	22.22
Homoptera	Aleyrodidae	4	0.36	22.22	6	0.73	22.22	22	2.49	33.33	3	0.41	22.22	8	0.98	33.33	7	1.14	33.33
	Aphididae	117	10.47	66.67	95	11.52	77.78	101	11.41	77.78	88	11.96	88.89	95	11.61	77.78	105	17.07	55.56
	Cicadellidae	14	1.25	55.56	15	1.82	77.78	8	0.90	55.56	9	1.22	66.67	17	2.08	77.78	8	1.30	44.44
Hymenoptera	Apidae	0	0	0	2	0.24	22.22	1	0.11	11.11	5	0.68	33.33	2	0.24	11.11	2	0.33	22.22
	Formicidae	475	42.49	100	299	36.24	100	478	54.01	100	312	42.39	100	278	33.99	100	205	33.33	100
	Insect parasitoids	27	2.42	100	40	4.85	88.89	14	1.58	66.67	25	3.40	88.89	19	2.32	100	17	2.76	77.78
	Parasitoid wasps	4	0.36	33.33	0	0	0	2	0.23	11.11	2	0.27	11.11	0	0	0	2	0.33	22.22
	Vespidae	0	0	0	0	0	0	0	0.00	0.00	0	0	0	1	0.12	11.11	1	0.16	11.11
Orthoptera	Acrididae	9	0.81	55.56	7	0.85	44.44	4	0.45	22.22	7	0.95	66.67	8	0.98	66.67	5	0.81	55.56
	Gryllidae	12	1.07	88.89	6	0.73	44.44	5	0.56	33.33	5	0.68	33.33	9	1.10	55.56	1	0.16	11.11
Thysanoptera	Thripidae	9	0.81	44.44	10	1.21	33.33	15	1.69	44.44	48	6.52	44.44	10	1.22	11.11	21	3.41	22.22
Lepidoptera		1	0.09	11.11	0	0	0	2	0.23	22.22	2	0.27	22.22	1	0.12	11.11	0	0	0
Isopoda		9	0.81	55.56	1	0.12	11.11	10	1.13	33.33	4	0.54	22.22	1	0.12	11.11	8	1.30	22.22
Mites		1	0.09	11.11	0	0	0	0	0	0	2	0.27	22.22	3	0.37	33.33	0	0	0
Spiders		159	14.22	100	46	5.58	100	23	2.60	88.89	16	2.17	77.78	127	15.53	100	23	3.74	100
Total		1118			827			887			736			818			615		
						2832									2169				

Table (8): Dominance and abundance (D% & A%) of pests collected from cowpea plantation during 2017 seasons, Fayoum Governorate

Orders and families		Fish cutlture warter			Nile fresh water		
		Total number	D %	A %	Total number	D %	A %
Homoptera Aleyrodidae	N20	24	5.58	37.5	40	8.64	50
	N40	60	13.95	37.5	65	14.04	50
	N60	82	19.07	37.5	90	19.44	50
Homoptera Aphididae	N20	10	2.33	25	29	6.26	37.5
	N40	28	6.51	50	39	8.42	12.5
	N60	52	12.09	37.5	62	13.39	50
Thysanoptera Thripidae	N20	8	1.86	12.5	18	3.89	12.5
	N40	17	3.95	25	20	4.32	12.5
	N60	27	6.28	12.5	32	6.91	12.5
Tetranychidae moving stages	N20	17	3.95	50	24	5.18	25
	N40	23	5.35	12.5	26	5.62	12.5
	N60	28	6.51	12.5	34	7.34	25
Homoptra Cicadellidae	N20	2	0.47	0	4	1	0
	N40	3	0.70	0	6	1.30	12.5
	N60	3	0.70	12.5	7	2	0
Diptera Agromyzidae	N20	25	5.81	100	28	6.05	100
	N40	28	6.51	100	31	6.70	100
	N60	34	7.91	100	37	7.99	100
Total		471			592		

Table (9): effect of two different water sources and N fertilizer on number of Arthropods (Spider, soil fauna, pests, and predators) and yield & protein cowpea

Treatments	Characters				
	Spiders No.	Soil fauna	Pests and predators/leaves	Yield	Protein
Water (W)					
Fish culture water	8.44	100.00	19.63	930.59^a	18.37^a
Nile water	6.15	76.63	24.67	848.32^b	16.98^b
$LSD_{5\%}$	NS	NS	NS	33.75	1.07
Nitrogen (N)					
N_{20}	9.72	95.89	14.31^c	793.01^c	16.78^a
N_{40}	9.61	85.72	21.63^b	875.48b	17.68b
N_{60}	2.56	83.33	30.50^a	999.88 ^{a}	18.55^c
$LSD_{5\%}$	NS	NS	7.23	54.94	0.29
Interaction					
$W_1\times N_{20}$	17.67	110.00^a	10.75^d	810.53^c	17.35^c
$W_1\times N_{40}$	5.11	91.67^{abc}	19.88^{bcd}	903.84^b	18.45^b
$W_1\times N_{60}$	2.56	98.33^{ab}	28.25^{ab}	1077.41^a	19.30^a
$W_2\times N_{20}$	1.78	81.78^{bc}	17.88^{cd}	775.84^c	16.22^e
$W_2\times N_{40}$	14.11	79.78^{bc}	23.38^{abc}	847.12^{bc}	16.92^d
$W_2\times N_{60}$	2.56	68.33^c	32.72^a	922.35^b	17.80^c
$LSD_{5\%}$	NS	24.21	10.22	77.70	0.41

not be used as the primary source of nitrogen and phosphorus for crops owing to its low concentration of these elements. Moreover, the small amount of nitrogen and phosphorus in pond water does not justify adjustment of recommended nitrogen and phosphorus rates for crops.

V - Effect on Protein content:

a. Effect of water sources Protein content: Table (9) show that total protein was significantly increased by two water sources where the highest total protein was obtained by Fish culture water (18.37%) compared with Nile water was 16.98%.

b. Effect of nitrogen Protein content: Data in the table (9) indicated that was significantly increased by added levels nitrogen fertilizers (N_{20}, N_{40}, and N_{60}) where the highest protein was 18.55%, 17.68% and 16.78% in N_{60}, N_{40}, and N_{20} respectively.

c. The interaction effect between water sources and nitrogen levels: The data tabulated in the table (9) showed that the main effect of interaction between irrigation water sources and nitrogen fertilization on total protein was highly significant in both seasons. The highest total protein in both seasons was 19.30% in the interaction between fish culture water and nitrogen fertilizer (W_1N_{60}). Compared with the interaction between Nile freshwater and nitrogen fertilizer (W_2N_{20}) where the lowest total protein was 16.22%.

Daramy *et al.*, (2016) found that cowpea seed N, seed crude protein and cowpea total plant N contents were significantly affected by N rates while the highest values were obtained at 30 kg N/ha.

Also, Li and Hu 2009 published that fish plays an important role in food security by providing many nutrients, including high-quality protein, omega-3 polyunsaturated fatty acids, and micronutrients.

Atijegbe *et al.,* 2014 showed that the low infestations by insect pests on plots treated with organic farming may be as a result of the slow release of nitrogen which made them less susceptible to insect pest attack. (Wardle, 2004 and Mace *et al.,* 2012) referred that Arthropods communities are critical for ecosystem functionality, with respect to direct and indirect interactions with plants, nutrient, and organic matter cycling. Eid *et al.,* (2014) published that recycling the drainage water of fish farming, rich with organic matter for agriculture use can improve soil quality and crops productivity and reduce the total costs of fertilizers by adding minimum doses from minerals fertilizers. Ferreira *et al.,* (2015) found that irrigation with produced water promotes important changes in soil fauna structure that justify its assessment for the maintenance and monitoring of agro-ecosystems. To our knowledge, this is the first evidence of how the mesofauna structure is influenced by the quality of water used for irrigation. In semiarid regions, seasonal effects naturally induce variations in the composition and abundance of soil organisms, even if the areas are irrigated. The responses of soil fauna to differences in season differ between the land-use types.

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